Exploratory Study on the Efficacy of Applying Mixed-Mode Pedagogical Approach in Teaching Maritime-Technical Course to Business Students

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Abstract

Technological developments in maritime transport have been evolved over many years to this new generation that highly caliber professionals are highly demanded in the maritime industry. Maritime education and training has to provide young professionals with the expertise in the handling of dangerous goods, the know-how of applying computing technology on board ships and better awareness of maritime environmental protection. Quality maritime education and training is indispensable for upholding and enforcing the International Convention on Standards of Training, Certification and Watch-keeping for Seafarers (STCW). Maritime administrations have been emphasizing pre-sea education in the journey of training up contemporary maritime professionals. Continual improvement on teaching and learning approaches is a natural activity to assure quality education in a rapidly changing world. The aim of this paper is to evaluate the efficacy of mixing traditional teacher-centered instructional approach with student-centered problem-based learning (PBL), to different extents, in improving business students' performance and learning effectiveness in a maritime-technical course. The findings from examination results and students' responses to the surveys at different stages of the course are used to infer the actual and perceived efficacy of employing PBL-styled laboratory to supplement traditional lecture. This study was first conducted in the spring semester of 2011 and was replicated in spring 2012 with a slight modification. Consistent results were obtained in the two years and showed that students performed better and perceived themselves learn more effectively through a mixed-mode approach with more PBL-styled laboratories. That mixed-mode pedagogical approach is therefore recommended as effective course delivering method for maritime-technical curriculum.

Keywords

Student-centered Learning; Problem-based Learning; Maritime Education; Maritime-technical Course; Learning Effectiveness; Mixed-mode Pedagogy

Introduction

The Hong Kong Polytechnic University (HKPU) is the only university providing maritime education with both commercial and technical training to business students in Hong Kong [1]. Maritime education in the institution, formerly named Hong Kong Polytechnic, started since early 70's. The emphasis was originally placed on technical subjects only and later shifted to shipping and transport logistics in mid 90's because of the new trend in the education market for the shipping, logistics and maritime industries in Hong Kong. However, the training in maritime-technical aspects, like maritime safety, maritime communication & navigation, ship construction, cargo operations and handling, etc., is still basic and essential to preparation of contemporary maritime professionals for the healthy development of the port of Hong Kong. With the support from the leaders in the maritime industry and local administration of Hong Kong, the institution is still contributing to maintain pre-sea education for technical expertise in order to meet the international standards set by the International Convention on Standards of Training, Certification and Watch-keeping for Seafarers (STCW). The maritime-technical courses offered in the institution mainly focused to the students of the engineering faculty in the past years but have later been re-targeted to business students because of restructuring the teaching departments of the faculty to align with the new trend in the education market. The years of traditional teaching experience in maritime education, especially the training for maritime technical components, have become turning into ineffectual teaching practices when the majority of target students are business students with a minor in maritime studies. Through student feedback questionnaire to collect

students' views on teaching/learning efficacy at the end of a maritime-technical course "LGT3x04 Navigation & Communication" in the academic year 2005/2006, over 33% of students felt too challenging in solving problems because of difficulty in understanding abstract principles of science/technology or weakness in generic analytical skills for formulation of solutions. Through informal interview with students, around 30% of interviewees had a perception that the traditional approach of knowledge transfer was too unilateral and was insufficiently effective to develop students' capacity for self-directed learning in maritime courses that were richly loaded with technical knowledge.

In this institution, there has always been a widespread climate of improving students' performance with effective teaching and aiming for better learning outcomes. It is the main driving force behind this study on comparison of different pedagogical approaches for delivering a maritime- technical subject to business students. The researcher then delved into pedagogical teaching approaches as determined by the curriculum required. The curriculum design of the course LGT3x04 requires students to achieve learning outcomes:- (a) analysis of functions of…; (b) evaluation of performance…; and (c) formulation of standards….; with an additional objective of developing students' skills in critical thinking and life-long learning. All these would not easily be achieved using traditional classroom instructional methods with emphasis on unilateral teacher-to-student information flow in 2-hour lecture and 1.5-hour laboratory every week throughout one semester. With consideration of students' perceptions on the insufficiency of the teaching methods for LGT3x04, and inspiration from some education development workshops at HKPU, the researcher then decided to introduce student-centered pedagogical element into the teaching of LGT3x04. The most appealing terminology come to him was 'problem-based learning'(PBL), which is a student-centered pedagogy and has been identified as an alternative teaching approach receiving more attention, in contrast to conventional instructional teaching approach, because of its strength in using simulation of real-life situations with contextualized problems of practice to initiate, stimulate, and focus on skill development and content learning [2] [3] [4].

Literature Review

Emergence of Problem-based Learning

The first problem-based learning (PBL) curriculum was introduced by Barrows [5] in 1960s at a medical school. Since then, PBL has become widespread across different subject areas worldwide and various views of PBL have been stirring up controversies regarding definition, learning theory and underlying philosophy, the PBL process and its subsequent variants, and its efficacy [6]. With the rapid widespread of PBL and the accompanying good evidence of the efficacy of PBL, PBL is claimed to bring more benefits to students including: development of effective reasoning process; development of self-directed learning skills; structuring of knowledge; improving retention of information; and increasing motivation for learning [7]. These advantages of PBL derived from experience in medical education may not be necessarily applicable to other disciplines but some studies exist to prove the efficacy of PBL in some subjects, like business education [8], engineering [9], legal education [10], and psychology [11].

The advantages of PBL are not confined to those listed by David et al. [6]. There are also other benefits documented in the literature including more positive attitudes of learners and instructors [12], improvement of reflective practice [13] and reinforcement of collaborative learning skills [14]. However, the superiority of PBL is not fully conclusive in all aspects. Some researches [15] [16] reveal that traditional teaching approach can better prepare students for tests of factual knowledge. More ironically, students facing excess failure in a PBL process become dissatisfied with anxiety, frustration [17] and discomfort [18]. Establishing cause-benefit relationship may be even more difficult than proving the benefits of PBL exist [19].

Advocacy of Mixing Traditional Instructional Approach with Problem-based Learning

In spite of hearing increasingly louder voices to advocate PBL, some literature espouse traditional instructional approach [20] [21] [22] [23]. Except explaining PBL format in curricular design [24], very little empirical study has been conducted to investigate the efficacy of PBL in improving students' learning effectiveness in maritime studies. The curriculum of LGT3x04 tightly weaves into foundation of basic principles of science and technology, which many business students may find unfamiliar, and may require highly structured and teacher-centered approach to contribute positively to their learning process. For a course requiring a certain level of factual knowledge as a foundation to deeper learning,

PBL should not be applied in isolation without the support of traditional lecturing for transfer of necessary informational and content knowledge. With all these concerns, it would be unwise to implement completely pure student-centered pedagogical approach with PBL in the teaching of LGT3x04. The results of some studies suggest that students learn better through a mixed mode of teacher-centered approach and PBL in favor of student-centered approach rather than purely through either teacher-centered or student-centered method. Because of the espousal studies [15] [25] [26] [27] [28], the present paper suggests to launch a maiden voyage of combining traditional lecture and PBL laboratory for LGT3x04 in spring 2011, followed by replicating itself to another cohort of students in 2012, for verifying the superiority of the mixed-mode approach over its traditional counterpart.

Method

The maritime-technical course "LGT3x04 Navigation & Communication" has been split into LGT3004 and LGT3504 for two different classes of students to enroll since 2009. The class of LGT3004 would be business students of an undergraduate degree program and the class of LGT3504 would be business students of a sub-degree program. Although the two classes of students came from different programs, they were arranged to attend common weekly lecture, followed by small-sized laboratory, with group size of around 20. Assume that they had similar academic background; they performed similarly if they were taught in the same way. The records of past years have verified this assumption. This study applied the mixed mode in different ways intentionally to the two classes in order to test the efficacy of the mixed-mode approach.

In spring 2011, the total number of students enrolled in LGT3004 at HKPU was 19 and the other class LGT3504 had 105 students. Both classes attended common lecture, followed by small-group laboratory sessions, every week from January to April over 14 weeks. Since the LGT3504 class was large in size, the students were sub-divided into five separate laboratory sessions, with a size of 21 per session every week. All the 19 students of LGT3004 were separated from LGT3504 students to attend another weekly laboratory session. The lecture method delivered to the two classes must be identical because of the arrangement of common lectures. The only difference was in the different timeline of applying PBL to their laboratory sessions, as illustrated in Figure 1 [29].

Figure 1 shows that both LGT3004 and LGT3504 received assessment at the same time in week 5, week 10 and week 16. PBL was applied to the laboratory sessions throughout the 14 weeks of the course LGT3004 but PBL was introduced to the laboratory sessions in only the second half of the course LGT3504 (i.e. after 7th week). During the first half of the course of LGT3504, students were given teacher-guided learning tasks listed on work sheet under supervision of instructors. Each student followed the instructors' demonstration to work on the tasks individually. By the end of the session, each student should have completed all learning objectives of the laboratory session. By completion of the learning tasks, students should have acquired analytic skills for problem solving and formulation of solutions or new standards. Basically, the problem solving approach is embedded in the learning tasks and students have to inter-relate each task to understand the logic of analysis in order to truly acquire the skills. In contrast, implementation of PBL required each laboratory group to be further subdivided into small teams, with 4 to 5 students per team. Instead of requiring students going through teacher-guided learning tasks in the whole laboratory, students were briefed the techniques for completion of basic tasks, followed by a group work that would require students to apply the techniques learnt in the basic tasks to simulate solving a real-life problem through role playing in the second half of the session. In the last 20 minutes of each PBL-structured laboratory session, a student would be selected from each team to share with the whole big group regarding evaluation of the learning progress in the role-play exercise, identification of difficulties / problems and recommendation of solutions. The plans of teaching/ assessment for 2011 and 2012 was almost identical, except that LGT3504 laboratory combined teacher-guided style and PBL style in 2011 but it was changed to a fully teacher- guided format in 2012, as illustrated in Figure 2.

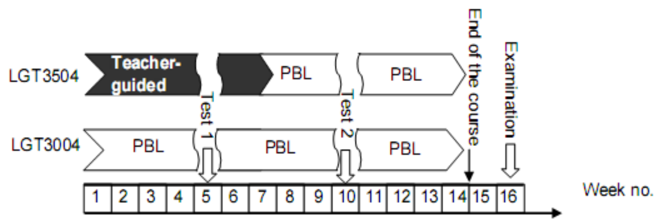

FIG.1 TIMELINE OF TEACHING/ASSESSMENT PLAN (2011)

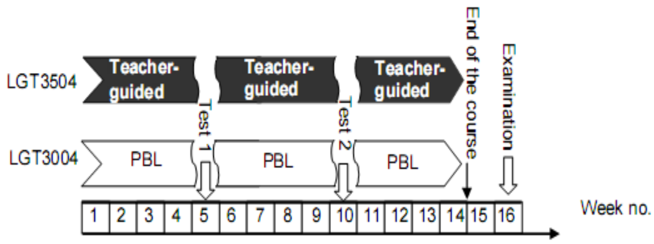

FIG 2. TIMELINE OF TEACHING/ASSESSMENT PLAN (2012)

In spring 2012, the number of teaching hours for the two classes remained intact with one common weekly conducted for both LGT3004 and LGT3504 but barely five weekly laboratory sessions were arranged because of only 13 and 61 students enrolled in LGT3004 and LGT3504 respectively. LGT3004 formed one laboratory session per week, whereas 15 or 16 students of LGT3504 enrolled in each of the remaining four weekly sessions.

The viewpoints of students collected in the feedback session would be useful to the design and revision of the coming laboratory sessions. Usually it is a good idea to purposely select those students who were reluctant to participate in team work or made the least contribution in doing role-play exercise throughout the PBL-styled laboratory. It conveys a positive message that each member of a team should participate actively or contribute as much as the other team members. For teacher-guided laboratory of LGT3504, feedback was welcomed around the end of each laboratory class but was in fact rarely received. Most of the students learnt individually although they were encouraged to share experience of learning among themselves. Students were reluctant to interact in the first few weeks until they seemed to mix well with one another after almost half of the course had passed.

Regardless of teacher-guided laboratory or PBL-styled laboratory, the learning objectives and the essential concepts required were aligned to the preceding lecture class to a certain extent. The aim of laboratory sessions is to stimulate deeper learning in formulating the skills of problem solving. Addressing the identified problem/difficulty is the key point in the concluding remarks by the instructor right after feedback session.

Questionnaires

The assessments conducted at the three points of time (i.e. week 5, 10 and 16) provided useful evaluation on the efficacy of the two different pedagogical approaches. In addition to using the assessment results as the efficacy indicator, students' perceptions on the teaching and learning approaches would be useful to understanding any perceived weakness or ineffectiveness in implementing the teaching approaches. The ultimate aim is to test whether the mixing of traditional lecture and PBL-styled laboratory is truly effective or not from students' points of views. Refer to Table 1 for the sample questionnaire administered to collect students' views. The same questionnaire was given to both LGT3004 and LGT3504 students regardless of the pedagogical approaches used in their laboratory classes. Student's responses to each item of the questionnaire could be any one of five options, SA, A, NSV, D and SD, which respectively stand for "Strongly Agree", "Agree", "No Strong View", "Disagree" and "Strongly Disagree", with score ranging from 5 to 1.

Questionnaires were administered to gather students' views of their learning experiences right after each of the first two assessments (i.e. week 5 and 10) and at the end of the course (i.e. week 14). The advantage of questionnaire is that it would enable the students to give anonymous feedback. This would hopefully increase response rate by virtue of the small class size of laboratories, and help with honesty in responses. The completed questionnaires were collected from students and then data were analyzed using the statistical software SPSS 20.

TABLE 1. SAMPLE QUESTIONNAIRE FOR ALL SURVEYS [29]

Item	Five items of questionnaire (Answer each question by marking a 'tick' in one of the five empty slots)	SA	A	NSV	D	SD
		5	4	3	2	1
1.	The learning approach implemented in the laboratory session in the past 4 weeks helped me understand better the contents of preceding lectures and/or achieve the learning objectives specified in the preceding lectures.					
2.	I learnt the required contents better or more from my classmates in the laboratory sessions over the past 4 weeks.					
3.	The way I learnt in the past 4 weeks can enable me to acquire the necessary skills of analytical thinking and problem-solving for tackling real-life problems or the problems in the test today.					
4.	My learning experience throughout the laboratories in the past 4 weeks can keep stimulating me or my classmates to learn more actively.					
5.	I would rate the overall quality of the teaching and learning approaches to be very good in the past 4 weeks.					

Results

For clarity and simplicity in discussion, the LGT3004 and LGT3504 classes in spring 2011 and spring 2012 are labeled as classes I to IV as shown in Table 2. Table 3 and Table 4 summarize mean scores and standard deviations of students' responses in the surveys administered in 2011 and 2012 respectively. The findings from students' results of assessments in 2011 and 2012 are respectively summarized in Table 5 and Table 6. These facilitate comparison of summary statistics across different classes of students.

TABLE 2. TAXONOMY OF MIXING DIFFERENT LABORATORY- LEARNING STYLES WITH TRADITIONAL LECTURES

	Class I	Class II	Class III	Class IV
Class size	n = 19	n = 13	n = 105	n = 61
Year 2011	LGT3004		LGT3504	
Year 2012		LGT3004		LGT3504
Laboratory-learning style	week 1~14 : Wholly-PBL laboratory		week 1~7 : Teacher-centered week 8~14 : PBL	week 1~14: Wholly teacher-centered laboratory

TABLE 3. FINDINGS OF THE SURVEYS FOR BOTH CLASSES IN 2011 (MEAN SCORE IS BOLD & STANDARD DEVIATION UNDERLINED)

Item	Surveys of Classes I and III in Spring 2011											
	1st round (wk 5)				2nd round (wk10)				3rd round (wk14)			
	I		III		I		III		I		III	
1.	**3.6**	<u>0.7</u>	**3.3**	<u>0.8</u>	**4.0**	<u>0.5</u>	**3.6**	<u>0.7</u>	**4.2**	<u>0.6</u>	**4.0**	<u>0.6</u>
2.	**3.8**	<u>0.6</u>	**2.4**	<u>0.7</u>	**4.2**	<u>0.7</u>	**3.7**	<u>0.6</u>	**4.3**	<u>0.5</u>	**4.1**	<u>0.7</u>
3.	**3.4**	<u>1.0</u>	**3.4**	<u>0.5</u>	**4.1**	<u>0.5</u>	**3.9**	<u>0.7</u>	**4.5**	<u>0.5</u>	**4.1**	<u>0.7</u>
4.	**3.6**	<u>0.7</u>	**3.1**	<u>0.7</u>	**3.8**	<u>0.6</u>	**3.6**	<u>0.7</u>	**4.1**	<u>0.5</u>	**4.0**	<u>0.7</u>
5.	**3.7**	<u>0.6</u>	**3.0**	<u>0.7</u>	**4.0**	<u>0.5</u>	**3.8**	<u>0.7</u>	**4.3**	<u>0.4</u>	**4.0**	<u>0.7</u>

TABLE 4. FINDINGS OF THE SURVEYS FOR BOTH CLASSES IN 2012 (MEAN SCORE IS BOLD & STANDARD DEVIATION UNDERLINED)

Item	Surveys of Classes II and IV in Spring 2012											
	1st round (wk 5)				2nd round (wk10)				3rd round (wk14)			
	II		IV		II		IV		II		IV	
1.	**3.8**	<u>0.8</u>	**3.9**	<u>0.6</u>	**4.2**	<u>0.7</u>	**3.6**	<u>0.8</u>	**4.4**	<u>0.7</u>	**3.4**	<u>0.5</u>
2.	**3.5**	<u>0.9</u>	**2.6**	<u>0.9</u>	**4.1**	<u>0.7</u>	**2.9**	<u>0.9</u>	**4.3**	<u>0.6</u>	**3.1**	<u>0.8</u>
3.	**3.7**	<u>0.7</u>	**3.9**	<u>0.8</u>	**4.2**	<u>0.7</u>	**3.7**	<u>0.8</u>	**4.2**	<u>0.6</u>	**3.5**	<u>1.0</u>
4.	**3.7**	<u>0.8</u>	**2.9**	<u>0.9</u>	**4.0**	<u>0.7</u>	**3.0**	<u>1.0</u>	**4.2**	<u>0.6</u>	**3.1**	<u>0.7</u>
5.	**3.6**	<u>0.8</u>	**3.4**	<u>0.7</u>	**4.1**	<u>0.5</u>	**3.5**	<u>0.7</u>	**4.1**	<u>0.7</u>	**3.4**	<u>0.8</u>

The examination consisted of three sections, A, B and C, to focus on the three required learning outcomes, as previously specified in the second paragraph of INTRODUCTION. The questions set in section A mainly focused on the learning outcome (a) which is closely relevant to the subject contents delivered to LGT3004 and LGT3504 students in Weeks 1 ~ 4. Similarly, the questions of sections B and C focused on the learning outcomes (b) and (c) respectively, and are relevant to the contents delivered in Weeks 6 ~ 9 and Weeks 11 ~ 14 respectively. Comparison of survey mean scores and assessment results can measure the efficacy of the different pedagogical approaches employed in LGT3004 and LGT3504 classes.

TABLE 5. SUMMARY OF ASSESSMENT RESULTS IN 2011 [29]

Spring 2011	Class I (n=19)		Class III (n=105)	
	Mean	Standard deviation	Mean	Standard deviation
Test 1	78.4%	9.3	80.4%	14.4
Test 2	84.5%	7.5	84.3%	5.2
Examination				
Section A	71.4%	3.5	39.6%	5.7
Section B	79.3%	3.8	48.2%	5.6
Section C	88.9%	4.7	90.0%	5.8

TABLE 6. SUMMARY OF ASSESSMENT RESULTS IN 2012

Spring 2012	Class II (n=13)		Class IV (n=61)	
	Mean	Standard deviation	Mean	Standard deviation
Test 1	86.8%	5.8	86.2%	11.8
Test 2	83.2%	3.6	85.4%	5.7
Examination				
Section A	70.4%	5.5	43.7%	7.1
Section B	72.7%	3.8	58.7%	8.2
Section C	77.9%	3.5	63.0%	5.8

The summary statistics in Tables 3 to 6 were analyzed to reveal any statistical significance in the influence to students' perception on learning effectiveness. Effect sizes (ES) [15] [30] [31] and p-values are summarized in Tables 7 and 8 to assess students' perceptions on the efficacy of the mixed-mode approach. Table 9 shows effect sizes and p-values, computed from summary statistics in Tables 5 and 6, to measure the actual efficacy of the approach for improving students' performance. With the assumptions of normal distribution, equal population variance, similar backgrounds and capabilities across all the LGT3004 / 3504 classes, effect size (ES) is computed as the difference of mean scores for two classes divided by their pooled standard deviation. The sign of effect size (ES) of each item is based on subtracting mean score of LGT3504 from mean score of LGT3004 (i.e. class I – III, or II – IV), and positive value represents higher score for the wholly-PBL laboratory learners. In the tables below, 'ns' is used to denote 'not significant' when p-value is greater than 0.05.

TABLE 7. COMPARISON OF SURVEY SCORES TO MEASURE THE EFFICACY PERCEIVED BY STUDENTS (SPRING 2011)

Item	Mean scores of Class I subtracting Class III					
	1st round (wk 5)		2nd round (wk10)		3rd round (wk14)	
	ES	p-value	ES	p-value	ES	p-value
1.	1.520	ans	2.364	0.0098	1.326	ans
2.	8.124	0.0000	3.227	0.0008	1.182	ans
3.	0	ans	1.182	ans	2.364	0.0098
4.	2.842	0.0026	1.161	ans	0.591	ans
5.	4.062	0.0000	1.182	ans	1.801	0.0371

ans stands for 'not significant'.

TABLE 8. COMPARISON OF SURVEY SCORES TO MEASURE THE EFFICACY PERCEIVED BY STUDENTS (SPRING 2012)

Item	Mean scores of Class II subtracting Class IV					
	1st round (wk 5)		2nd round (wk10)		3rd round (wk14)	
	ES	p-value	ES	p-value	ES	p-value
1.	-0.505	ans	2.473	0.0079	5.974	0.0000
2.	3.229	0.0009	4.463	0.0000	5.041	0.0000
3.	-0.824	ans	2.061	0.0215	2.399	0.0095
4.	2.924	0.0023	3.384	0.0006	5.197	0.0000
5.	0.899	ans	2.895	0.0025	2.885	0.0026

2ns stands for 'not significant'.

TABLE 9. MEASUREMENT OF THE ACTUAL EFFICACY BY COMPARISON OF STUDENTS' ASSESSMENT RESULTS (2011 AND 2012)

Mean scores of LGT3004 subtracting LGT3504 for two consecutive years				
	Class I – Class III (Spring 2011)		Class II – Class IV (Spring 2012)	
	ES	p-value	ES	p-value
Test 1	-0.58	ans	0.18	ans
Test 2	0.14	ans	-1.31	ans
Examination				
Section A	23.338	0.0000	15.358	0.0000
Section B	23.070	0.0000	7.256	0.0000
Section C	-0.775	ans	10.300	0.0000

ans stands for 'not significant'.

Discussion

This study is designed to compare students' performance and perceptions on learning effectiveness with respect to different learning approaches for LGT3004 and LGT3504, and then empirical results can be used to draw conclusion on which learning approach can more effectively improve perceived learning effectiveness and actual performance of students. The grand mean scores for the four classes in each round of the surveys, computed from the summary statistics in Tables 3 and 4, are also summarized below in Table 10.

TABLE 10. SUMMARY OF GRAND MEAN SCORES IN THE THREE ROUNDS OF THE SURVEYS CONDUCTED IN YEARS 2011 AND 2012

	Class I	Class II	Class III	Class IV
Class size	19	13	105	61
Spring 2011	LGT3004		LGT3504	
Spring 2012		LGT3004		LGT3504
1st Round	3.62	3.66	3.04	3.34
2nd Round	4.02	4.12	3.72	3.34
3rd Round	4.28	4.24	4.04	3.30

Improvement of Students' Perceptions on their Learning Effectiveness with respect to Learning Approaches

In Table 10, the grand mean scores in the three rounds of surveys for class I are 3.62, 4.02 and 4.28 respectively. These results reflect that class I's perceptions on weaving conventional lecture and PBL-styled laboratory together were quite positive throughout the whole semester of spring 2011. Similarly, 3.66, 4.12 and 4.24 are the grand means for class II in the three rounds of surveys throughout spring 2012. The trends of progressively increasing mean scores in students' perceptions shows that both classes I and II felt more and more satisfactory with constantly employing PBL-styled laboratory to supplement traditional lecture. This can be explained by Albanese and Mitchell's research [15] about students' preference for PBL increasing with more exposure to the approach. These positive trends of perception scores in classes I and II also correlate with the consistently high scores in all assessment results of LGT3004 students in spring 2011 and spring 2012 respectively, as shown in Tables 5 and 6. There is no doubt to the effectiveness of employing the mixed-mode pedagogical approach to teach LGT3004. These findings are consistent with results of better performance of PBL students as reported in Albanese and Mitchell's study [15], and Vernon and Blake's study [16].

For class III in spring 2011, their grand mean scores in the three rounds of surveys shown in Table 10 are 3.04, 3.72 and 4.04 respectively. The grand mean score 3.04 is the result obtained from the first round of survey in week 5, and it correlates to the fact that the students of class III have undergone their laboratory sessions of teacher-centered style during weeks 1 – 4. This relatively lower grand mean score 3.04 infers students' moderately weak preference for teacher-guided laboratory tasks in the beginning of the course. After

week 7, the students of class III began using the PBL approach for all laboratory sessions in the remaining half of the course. There are obvious increases in the grand mean score from 3.04 to 3.72 and 4.04 in the second and third rounds of the surveys. These results infer more positive responses of class III to the mixed-mode pedagogical approach (i.e. traditional lecture mixed with PBL-styled laboratory) that commenced after the first round and before the second round of the surveys. From these findings, we can infer that class III students accepted the change of laboratory learning approach from teacher-centered style to PBL style and perceived the latter as a more effective way of inspiring themselves to learn better and stimulating active learning through more group interactions among themselves [32]. This inference also agrees with the examination results of LGT3504 students in spring 2011, as shown in Table 5. Section A was designed to measure the learning outcomes in weeks 1 ~ 4. The average mark of 39.6% in section A, which is the lowest one among the three sections of the examination, reflects poor performance for a requirement of relatively long-term retention of factual knowledge. The average mark of 48.2% in section B, which was designed to measure students' performance in weeks 6 ~ 9, is a little bit better than the mark of section A. This may correlate to introducing the PBL approach to laboratory sessions in the middle of the period of weeks 6 ~ 9. The improvement of performance is not very significant since the PBL approach was employed in weeks 8 ~ 9 and students needed time to become accustomed to the new learning style in their laboratory sessions. However, section C of the examination with the aim of measuring the performance in weeks 11 ~ 14 shows a big leap in performance. A very good average mark of 90.0% accords with the persistent use of the PBL approach in laboratory sessions over the same period. It is an evidence to prove PBL laboratory learners outperforming traditional learning counterparts [15] [16] and to support supplementing conventional lecture with PBL-styled laboratory.

In contrast to the cohort of spring 2011, the wholly teacher-centered learners (i.e. class IV of spring 2012) responded rather less positively as reflected by their grand means lying between 3.3 and 3.4 as shown in Table 10. These results can be correlated to the fact that the students of class IV were provided with a series of purely teacher-guided laboratories to supplement traditional lectures throughout the whole semester. The findings infer that class IV perceived teacher-guided laboratory tasks mixing with teacher-centered lectures as a less effective method to help them learn or to stimulate them to learn actively. Being attributable to the non-PBL approach employed in the whole series of laboratories, the average marks ranging from 43.7% to 63.0%, as shown in Table 6, clearly depict a picture of marginal to barely satisfactory performance by class IV in the three sections of examination. The results of examination for class IV markedly contrast with the persistently good examination results (70.4%, 72.7% and 77.9%) as demonstrated by students of class II, who were PBL laboratory learners studying together with class IV (i.e. wholly teacher-centered mode) in the same course for the same semester. By simply looking at the trends of survey mean scores over three rounds and comparing examination average marks across the four classes of students, better performance and perceived learning effectiveness can be observed in accompanying with more exposure to using PBL approach for laboratory learning.

Investigating Perceived Efficacy in connection with Learning Approaches in different classes

According to Tables 7 and 8, effect sizes and p-values are used for comparing perceived efficacy across different classes using different pedagogical modes. They show some statistically significant differences in learners' perceptions on learning effectiveness between mixed-mode with wholly-PBL laboratory (i.e. class I and class II) and partly-PBL or wholly teacher-centered laboratory (i.e. class III and class IV). By virtue of the results obtained from the first round of survey (in week 5) disregarding spring 2011 or 2012, it can be identified that students of class I (class II) responded more positively than students of class III (class IV) in items 2 and 4. These positive responses are attributed to requiring only class I (class II) to complete PBL-styled role-playing exercises and small-group discussion tasks during weeks 1 ~ 4. These statistically significant findings are consistent with results of some studies on more stimulating students experiences [32], and learning more from students' discussions [33].

On the other hand, there is no significant differences in the measurement of items 1 and 3, as shown in Tables 7 and 8. It could be explained by the transfer of mainly factual knowledge which does not necessitate accumulation of complex problem solving skills during the first four weeks of the course. Acquisition of factual knowledge may not be advantageous to the

wholly-PBL laboratory learners (i.e. class I and class II). In addition, the measurements through these two items are more closely related to individualized learning effectiveness than to cooperative group learning effectiveness. It is expected that the perceived efficacy of the mixed-mode approach on individualized learning would not be necessarily higher or lower than that of traditional counterpart [34] in both years 2011 and 2012. Item 5 of the survey for spring 2012, as shown in Table 8, also shows no significant differences. It can be explained by students' lack of acquaintance with the advantages of the PBL approach in stimulating deep learning and active learning from group participation in the beginning of the course. It is concluded that PBL and traditional learning styles produce no significance differences in perceived efficacy for learning factual knowledge. However, they indeed produce significant difference in actual efficacy for improvement of performance, as explained in later paragraph. Retention of factual knowledge may last longer by undergoing a PBL process [35].

The course commenced to introduce more and more complex issues of real-life situations after week 5. This requires students to think deeply and holistically, and to develop their capacity for self-directed learning. PBL not only encourages students to generate enthusiasm for learning but also motivates them to learn as a team for creation of innovative ideas beyond their own preconceptions and for acquisition of a body of professional knowledge [2]. With these challenges incorporated in the curriculum, the teaching plans for laboratories of class I and class II were homogeneously PBL-styled and students would have enough time to get acquainted with the student-centered learning approach. Students could be benefited more and sooner. However, the teaching plans for laboratories of class III and class IV were featured with partly-PBL and wholly non-PBL respectively. This design of employing PBL to different extents in laboratory sessions is to facilitate comparison of perceived learning effectiveness and performance of students.

The findings in the second and third rounds of surveys for spring 2011, as shown in Table 7, present a very different picture compared to the findings for spring 2012 in Table 8. Compared to two items marked with 'not significant' in the first round of survey, as shown in Table 7, there are three items (items 3 to 5) in the second round of survey showing no significant differences in the same table (i.e. the same spring semester of 2011). It is because both class I (i.e. mixed-mode with wholly-PBL laboratory) and class III (i.e. mixed-mode with partly-PBL laboratory) of spring 2011 began from week 7 to receive the same kind of PBL-styled pedagogical approach. Before the second round of survey was administered, most of students of class III would have commenced to recognize the effectiveness of the PBL approach after using this approach in weeks 8 ~ 9, and their responses tended to become closer to students' responses of wholly-PBL laboratory learners (i.e. class I students). It is absolutely reasonable to see more items in Table 7 showing no significant differences in the surveys for the second and third rounds. The trend of more items showing no significant differences indirectly indicates improvement to students' perception on learning effectiveness. In the third round of survey, there are although still only three items (items 1, 2 and 4) showing no significant differences, the item 5 with a p-value of 0.0371 is of relatively mild significance in comparison with the other very small p-values in Table 7. This could be interpreted as a slight improvement to students' perception to learning effectiveness in spite of its little significance. More importantly, there is a clear picture that the wholly-PBL laboratory learners (i.e. class I) were generally more positive toward learning effectiveness of their mixed-mode approach (i.e. traditional lecture mixed with PBL laboratory) than the partly-PBL counterparts (i.e. class III).

In contrast, Table 8 shows significant differences in the responses to all the five questionnaire items between class II (i.e. mixed-mode with wholly-PBL laboratory) and class IV (i.e. wholly teacher-centered mode). This result infers that PBL laboratory learners demonstrated a strong appreciation to the effectiveness of their mixed-mode approach whereas teacher-centered learners demonstrated a significantly weaker appreciation to the effectiveness of their homogeneously teacher-centered instructional approach. Discrepancy is naturally less extreme for comparison of class I versus III than comparison of class II versus IV. More significant differences are observed in comparing perceived learning effectiveness of class II and class IV since the p-values in Table 8 are generally less than those in Table 7. It is again a strong evidence to infer that perceived efficacy can be improved to a greater extent with more exposure to using PBL approach in laboratory sessions.

Measure Actual Efficacy of PBL for Improving Students' Performance with respect to Learning Approaches in different classes

In Tables 5 and 6, the assessment results of LGT3004

and LGT3504 are very close to each other for Test 1 and Test 2. Table 9 summarizes effect sizes and p-values, computed from the summary statistics of Test 1, Test 2 and Examination in Tables 5 and 6. Table 9 shows no significant differences between the two classes for both of the two tests in both of the two years since p-value for any of the Tests is certainly at least greater than 0.09. The results from comparison of class I (class II) and class III (class IV) in the Tests 1 and 2 show no significant differences between the efficacies of using PBL and using non-PBL laboratories. These results may be of lower significance because the two tests were designed to test a relatively small scope of subject contents in a rather short duration of time (usually one hour). The questions of Tests 1 and 2 could be not challenging enough to precisely differentiate PBL-learners and non-PBL learners in terms of knowledge and abilities. These insignificance results could also be explained by little discrepancy between PBL and non-PBL approaches in making short-term impact on students' performance. Deep learning in fact takes time to happen and appear in students' performance. The learning time in four or five weeks may not be adequately long enough to allow students learning deeply and developing their own knowledge.

In spite of insignificant findings from the Tests, the examination results in the three sections, A, B and C, clearly articulate the influence on improving students' performance in examination through mixing traditional lecture with PBL-styled laboratory. Students of class III (class IV) partly (wholly) using teacher-centered approach in their laboratory sessions would be good at capturing factual knowledge [15] [16] through straightforward and shallow rote learning [34], however that conventional style could not motivate them to learn deeply. They may achieve good performance in short term as reflected by the good average marks in Test 1 but their good performance could not last long without putting efforts in deep learning [15] [16]. Being attributable to teacher-centered approach in the first half of the course, the weak performances of class III (i.e. mixed-mode with partly-PBL laboratory) in sections A and B of examination, as illustrated in Tables 5, contrast markedly with the persistently good examination results of class I (i.e. mixed-mode with wholly-PBL laboratory) in the corresponding sections of examination. This observation can be verified by referring to the results of effect sizes in Table 9 and the accompanying small p-values. The p-values of nearly all zero is a very strong evidence to infer that the mixed-mode learners having undergone wholly-PBL laboratory outperformed those having undergone partly-PBL laboratory in the first two sections of examination for spring 2011. The only exception is the result in section C of examination for spring 2011, which presents a negative value of effect size. This finding indicates no significant differences in students' performance between class I and class III for section C of examination because both class I and class III were wholly using PBL approaches during the laboratory sessions of weeks 11 ~ 14 to learn the subject contents for section C of examination, as illustrated in Figure 1. This finding conveys a very clear message that students of class III could also perform as good as or even better than students of class I if appropriate PBL approach is applied appropriately to stimulate students of class III to learn as deeply and actively as students of class I. This proves positive influence on students' performance in examination through mixing wholly PBL-styled laboratories with conventional lectures. Another convincing evidence can be found in the results obtained from the cohort of students in spring 2012, as shown in Table 9. Students of class II (i.e. mixed-mode with wholly-PBL laboratory) strongly outperformed students of class IV (i.e. wholly teacher-centered mode) as reflected by absolutely significant differences in the examination results in all the three sections, A, B and C, according to the p-values of nearly all zero.

Conclusion

In summary, the aim of this paper has been achieved. The results of the surveys strongly infer that the perceived efficacy of the mixed-mode pedagogical approach for the maritime-technical course LGT3x04 can be improved by giving business students more exposure to PBL-styled laboratory learning activities. In other words, employing a mixed-mode pedagogical approach with more PBL-styled laboratory to supplement traditional lecture can improve business students' perception on their learning effectiveness in maritime-technical curriculum of this type, which are suitable for employing simulation, role-playing exercises and discussion tasks in group collaborative learning. In addition to improvement of perceived efficacy, the results of examination confirms the inference that the actual efficacy of the mixed-mode pedagogical approach for improving business students' performance in examination for the maritime-technical course can be increased by

supplementing traditional lecture with more PBL-styled laboratory learning activities. By following the direction of this research, we may carefully investigate the appropriateness of employing the mixed-mode pedagogical approach in other technical subjects of maritime studies, or even in a wider scope of maritime education and training [24].

Weaknesses in PBL Implementation and Future Study

In spite of the positive evidence proving the effectiveness of combining traditional teacher-centered and PBL-styled student-centered pedagogical approaches to help students achieve better performance and perceived learning effectiveness, it would be incautious to overlook that PBL-styled curriculum cannot be straightforwardly devised and tailor-made for all kinds of subject contents. There is a critical issue of choosing content coverage for PBL approach. It is often not easy to decide whether PBL approach can be used and how much contents should be taught in PBL style. This issue could be extended to students' bewilderment in deciding how important and confident they perceive active search for knowledge and accurate identification of core knowledge for a maritime-technical course through the designed tasks of the PBL-styled laboratory. It is not uncommon to hear from students' feedback about their discomfort with PBL regarding imprecise delimitation of the required scope of core knowledge after completion of some PBL sessions that included complex elements of real-world problems. This type of weakness in PBL curriculum has been reported by some researchers of medical schools [18].

In contrast to the advocacy of deep learning through PBL approach, there are indeed some studies [36] [37] reporting the weakness of PBL lacking the certainty of assuring students to learn up to the required breadth of contents. The evidence reported in the studies shows that students were able to identify merely around two-third of the learning objectives in PBL-styled curricula. Around one-third of the expected learning objectives could not be identified and/or achieved by students themselves. It is likely to have a big mismatch between the actual breadth of knowledge that students will acquire and the required scope of core knowledge that students are expected to acquire from learning through a fully PBL-styled curriculum. It is an unquestionable fact that there is a lack of theoretical and empirical investigation on the ideal or better pedagogical approach for maritime education, or more precisely, for the teaching of maritime-technical courses to students without science/technical background.

Although this study could provide a reflection on combining traditional instructional approach and PBL approach as a teaching strategy for teaching a relatively technical course to non-technical students, the researcher has taken great care to choose subject contents of easily identifiable learning objectives for inquisitive style of collaborative group learning with multiple viable solutions [34] [38] to fit into PBL implementation within laboratory environment. It is better to stay conservative than to be too ambitious to over-estimate the benefits to students' learning through employing a fully PBL-styled curriculum.

In addition, this study has a weakness of relying on written assessment for measurement of the efficacy of the mixed-mode pedagogical approach. The format of written examination in three hours has already limited the variety of skills for solving real-world problems, especially in the maritime world. Different formats of evaluation and assessment, like use of non-written formats, could be studied to formulate a better framework of measuring students' performance [39] [40]. A lot of topics in maritime-technical disciplines rely heavily on use of computer simulation software to simulate human decision making process in real-world maritime environments to meet the aim of pre-sea education and professional training.

Last but not least, assessment with computer simulation [41] [42] could be an additional method to evaluate and measure students' performance so as to reflect accurately the efficacy of different teaching and learning approaches for quality maritime education and training. Empirical research on using computer simulation software for performance-based assessment could shine new light in this field to further study on the ideal or better approach of teaching and learning for the next generation of maritime professionals.

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